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(54) Automotive accoustic insulation panel assemblies

(57) An insulation panel assembly 10 for interior surface of a passenger compartment of a motor vehicle comprises an insulation panel 11 conforming to a surface 13 of a vehicle body on which it is to be mounted. Spacer ribs 12 project from a reverse surface of the panel 11. The clearance between the insulation panel 11 and the body surface 13 is accurately determined by the tips of the spacer ribs 12 abutting the body panel 13. This clearance is not affected by an absorption layer 14 which may be interposed between the panel 11 and the body surface 13. A double wall structure is maintained, and a favourable sound insulation effect is assured for a long period.

A process for extrusion-moulding of the panel is also described.

FIG. 4

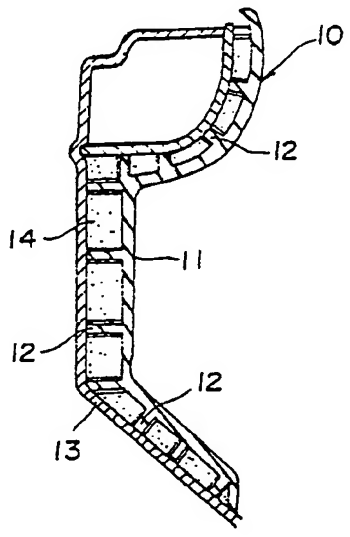

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FIG. 1

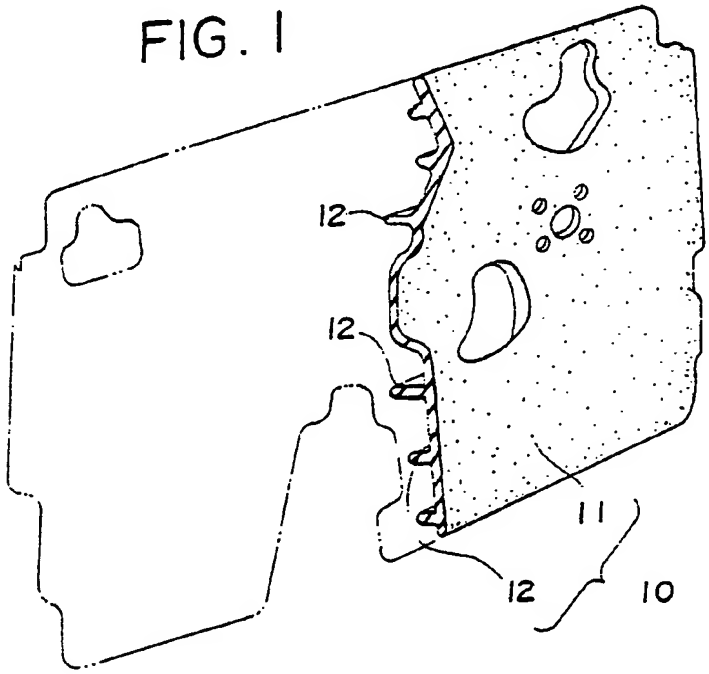

FIG. 2

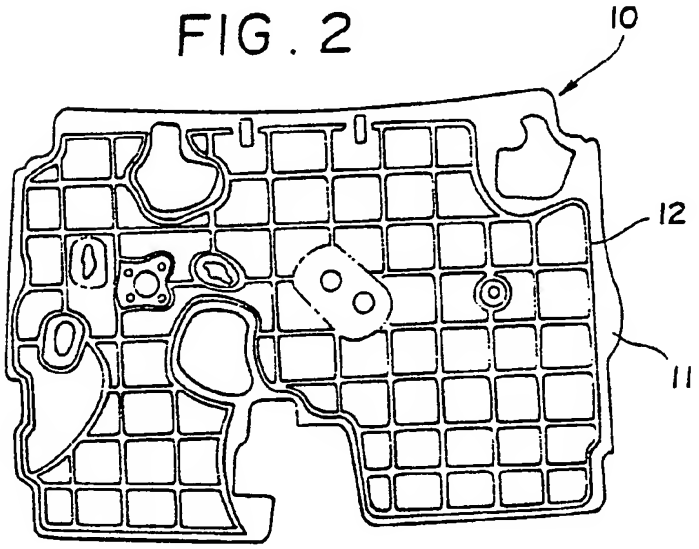

FIG. 3

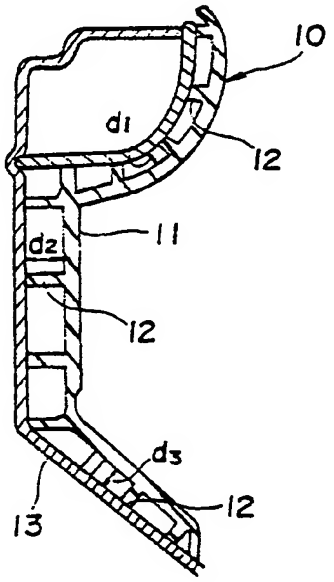

FIG. 4

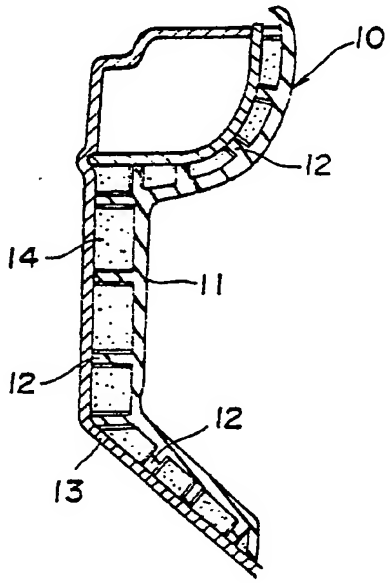

FIG. 6

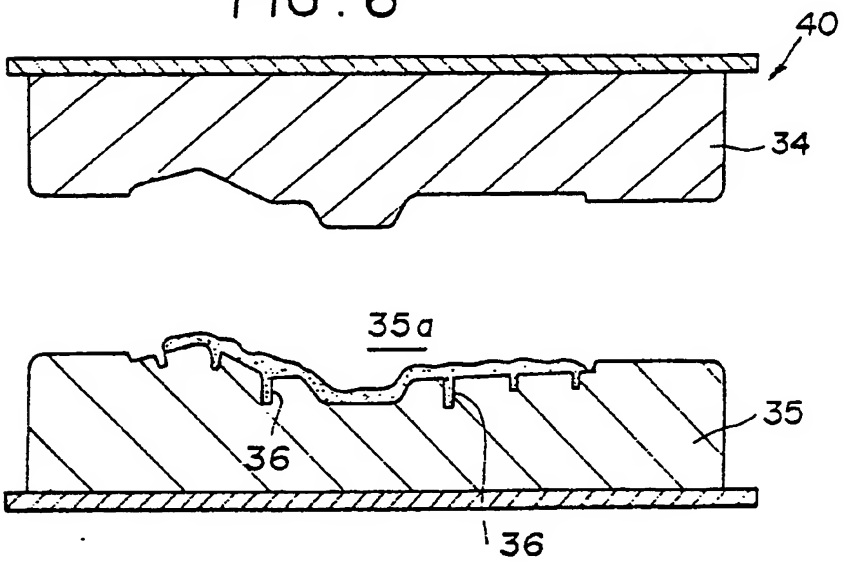

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FIG. 5

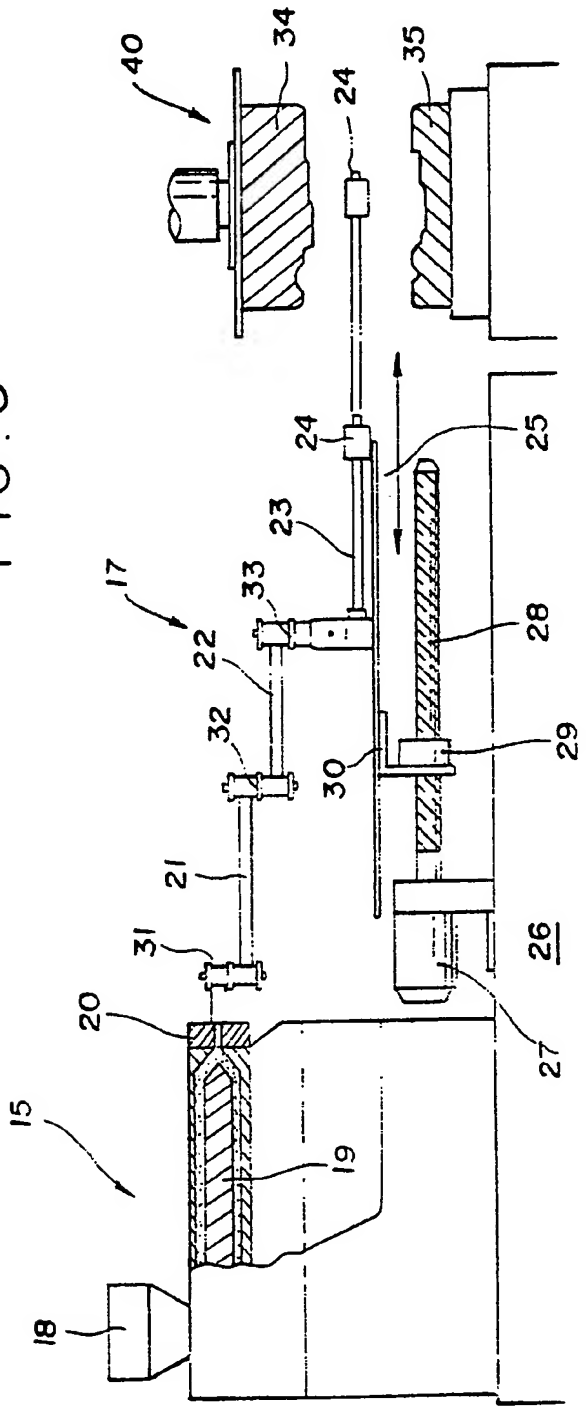

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FIG. 7

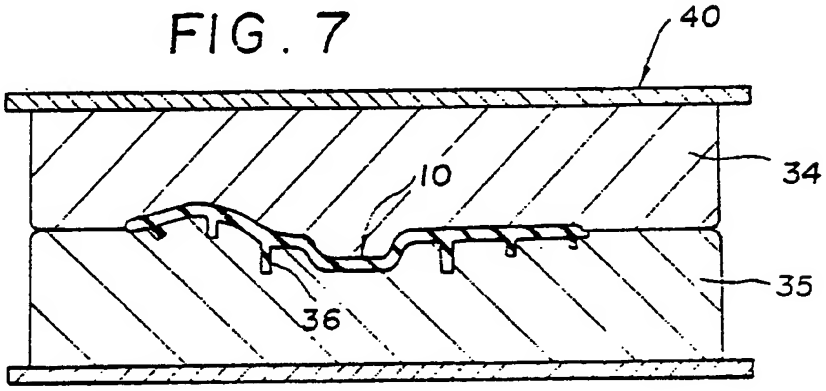

FIG. 8

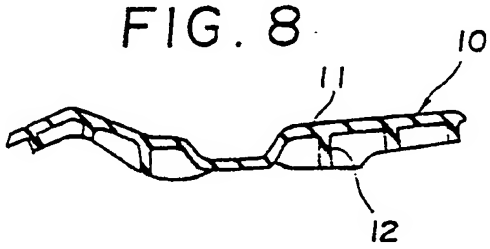

FIG. 9

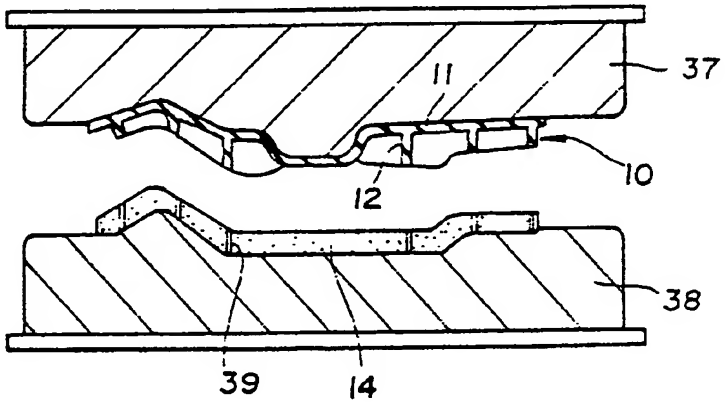

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FIG. 10

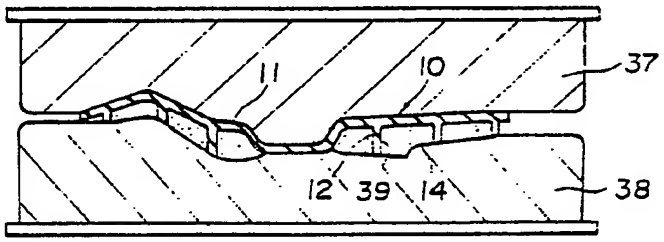


FIG. 11

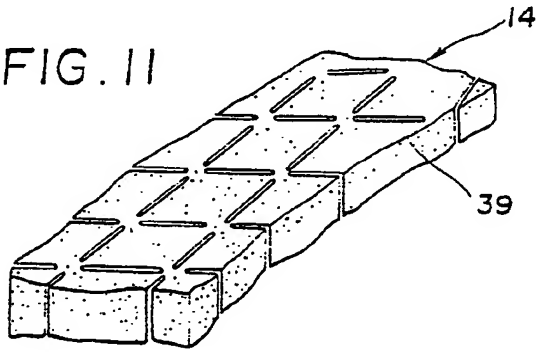


FIG. 13

PRIOR ART

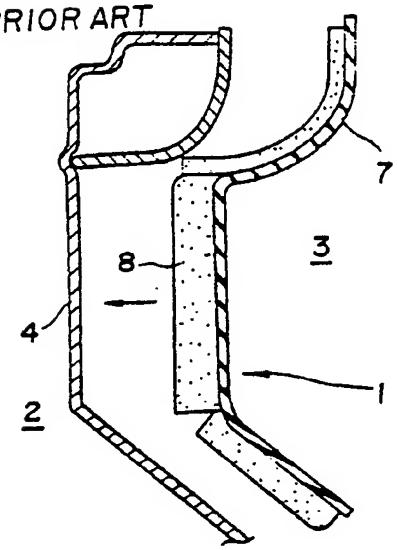
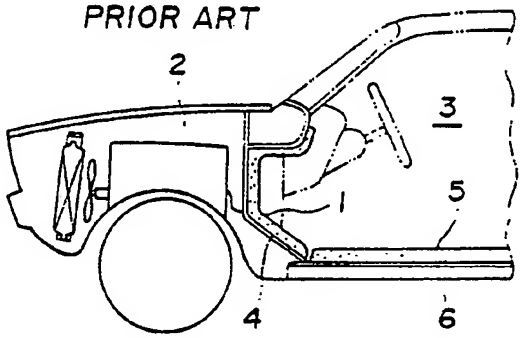


FIG. 12

PRIOR ART



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TITLE

Automotive Insulation Panel Assemblies

DESCRIPTION

The invention relates to acoustic insulation panel assemblies suitable for use on a bulkhead panel, a dashboard panel, a floor panel and other body panel parts of automotive vehicles, and also to apparatus for manufacturing such panel assemblies.

To keep noise from the passenger compartment of a motor vehicle, various forms of insulation are applied to parts of the interior wall surfaces. In time these have been found to deteriorate, change their setting in the vehicle body, and lose their insulating properties.

The invention provides an insulation panel assembly for an interior surface a motor vehicle comprising an insulation panel conforming to the surface on which it is to be mounted, and spacer means projecting from a reverse surface of the insulation panel.

The spacer means may consist of ribs in the reverse surface of the insulation panel, the clearance between the insulation layer and the body surface being accurately determined by the tips of spacer means abutting the surface. This clearance is not affected by any change in the quality of an absorption layer which may be interposed between the insulation panel and the surface. Thus, a double wall structure is maintained, and a favorable sound insulation effect is assured for a long period.

The gap between the insulation layer and the body surface can be varied from one place to another by varying the height of the spacer means. Thus production efficiency can

be achieved.

The spacer means may comprise a plurality of ribs integrally projecting from the reverse surface of the insulation panel. An absorption layer of porous material, such as urethane foam, felt, or glass wool, for example may be interposed between the insulation panel and the body surface. If the absorption layer consists of molded foam material, it may be provided with slits for receiving the spacer ribs. Alternatively, the absorption layer may consist of foam material which is formed in the space between the insulation panel and the body surface.

Such insulation assemblies can be simply and economically manufactured using apparatus according to the invention comprising an extruder for supplying a sheet of thermoplastic material in a plastic state, a first mold part having a plurality of cavities for forming spacer means of the assembly, and a second mold part adapted to cooperate with the first mold part for forming the thermoplastic material into the assembly.

Preferably, the apparatus also comprises means for moving an outlet of the extruder for laying the sheet of thermoplastic material over the mold surface of the first mold part.

Drawings

Figure 1 is a fragmentary perspective view of a first embodiment of a dashboard insulation panel assembly according to the invention;

Figure 2 is a rear view of the assembly shown in Figure 1;

Figure 3 is a sectional view of the assmebly shown in Figures 1 and 2 mounted to a dashboard panel;

Figure 4 is a sectional view like Figures 3 of a second

embodiment of the dashboard insulation panel assembly according to the invention which is additionally provided with an absorption layer;

Figure 5 is an overall fragmentary view of apparatus according to the invention for producing the dashboard insulation panel assembly;

Figure 6 is a sectional view of a press forming mold set for use in the apparatus of Figure 5;

Figure 7 is a view similar to Figure 6 showing the press forming mold in its fully closed state;

Figure 8 is a sectional view of the dashboard insulation panel assembly of Figure 7 removed from the mold set;

Figures 9 and 10 are views similar to Figures 6 and 7 showing a press forming mold set for producing the second embodiment panel assembly according to the invention in different stages of production;

Figure 11 is a fragmentary perspective view of an absorption layer;

Figure 12 is a simplified sectional view of an automobile to show a conventional dashboard insulation panel assembly and a floor insulation panel assembly; and

Figure 13 is a more detailed sectional view corresponding to Figure 12.

Figures 1 through 3 show a first embodiment of the insulation panel assembly according to the present invention as applied to a dashboard insulation panel assembly. This dashboard insulation panel assembly 10 comprises an insulation panel 11 which is made by press molded PVC resin, rubber material or other plastic material into a shape which is substantially conformal to a dashboard panel 13 (Figure 3) on which it is to be mounted, and a plurality of spacer ribs 12 which are integrally provided to the reverse surface of the insulation panel 11. As best shown in Figure 2, the spacer ribs 12 are formed into the shape of a grid or grill.

Figure 3 shows how this insulation panel assembly 10 is mounted to a dashboard panel. The insulation panel 11 is provided with a shape which follows the contour of the dashboard panel 13 to which it is mounted, and the spacer ribs 12 automatically define a certain gap between the insulation panel 11 and the surface of the dashboard panel 13 with the tips of the spacer ribs 12 abutting the surface of the dashboard panel 13. Thus, the spacer ribs 13 assure a certain optimum layer of air to be provided between the insulation panel 11 and the dashboard panel 13 for a favorable acoustic insulation. The spacer ribs 13

provide additional advantage of increasing the rigidity of the insulation panel 11.

If desired, the thickness of the insulation panel 11 may varied from one location to another so as to produce an optimum acoustic insulation for a given amount of material. Likewise, by varying the heights of the spacer ribs 13 from one location to another as shown by dimensions d_1, d_2 and d_3, the thickness of the air layer between the insulation panel 11 and the dashboard panel 13 may be varied from one location to another. This is advantageous because, by making the distance between the insulation panel 11 and the dashboard panel 13 vary from one location to another, the resonance of the air layer can be avoided and an optimum acoustic insulation can be achieved.

Thus, according to this embodiment, since absorption material such as felt, urethane foam or the like for defining an air layer can be omitted by the provision of the spacer ribs 13, a significant economy of material, simplification of the production process and reduction of the weight of the product can be accomplished at the same time.

Figure 4 shows a second embodiment of the present invention. In this embodiment, an absorption layer 14 made of material such as felt, urethane foam, glass wool or the like is interposed between the dashboard panel 13 and the insulation panel 11. According to this embodiment, since the clearance between the dashboard panel 13 and the insulation panel 11 is determined by the spacer ribs 12, the size of the

clearance will be maintained at a fixed level indefinitely even after the material of the absorption layer 14 has degraded, and the insulation panel assembly 10 will continue to be effective in keeping off noises from the passenger compartment for an extremely long period of time. Furthermore, since the cavities defined by the insulation panel 11, the spacer ribs 12 and the dashboard panel 14 are filled with the absorption material and, thereby, generation of standing waves and resonance phenomena can be effectively prevented.

Now the process of forming the dashboard insulation assembly 10 is described in the following with reference to Figures 5 through 8.

Figure 5 shows the apparatus for supplying thermoplastic resin material in a semi-molten state. This apparatus comprises an extruder 15, a movable die unit 17 and a press mold set 40. First of all, the extruder 15 comprises a hopper 18 for supplying pellets of thermoplastic resin material into the main part of the extruder 15. If desired, filler such as wood powder may be mixed with the thermoplastic resin material. This extruder 15 includes a screw or auger unit 19 comprising a heated barrel, a single screw or auger received therein, and a breaker plate 20 provided at a terminal end of the barrel for feeding the material to the movable die unit 17 from an orifice provided therein.

In the moveable die unit 17, molten resin is supplied from the breaker plate 20 of the extruder 15

to a die 24 for supplying sheet material by way of a first through a third supply tube 21, 22 and 23, which are connected by way of hinges 31 through 33 which permit articulation of these tubes 21 through 23 relative to each other and relative to the breaker plate 20. The die 24 and the third supply tube 23 are securely fixed to the upper surface of a movable base 25 which is in turn adapted to move relative to a fixed table 26 in the direction indicated by an arrow in Figure 5. In this embodiment, a servomotor 27 is mounted to the fixed table 26 and a screw rod 28 is attached to the output shaft of the servomotor 27. A ball nut 29 which threads with the screw rod 28 is attached to the lower surface of the moveable base 25 by way of a bracket 30.

Thus, as the servomotor 27 is turned, the moveable base 25 moves in a reciprocating manner by a stroke which depends on the rotational speed and the rotational direction of the servomotor 27, by way of the feed screw mechanism consisting of the screw rod 28 and the ball nut 29, and the die 24 for supplying sheet material moves likewise in a reciprocating manner following the motion of the moveable base 25.

Following the reciprocating motion of the die 24 for supplying sheet material, the first supply tube 21 and the second supply tube 22 are allowed to move in the fashion of a pair of mutually pivoted links in a plane parallel to the major surface of the moveable base 25 or the fixed table 26. This movement is made possible by the provision of the hinges 31 through 33.

As a result, molten resin is continuously introduced from the breaker plate 20 to the die 24 for supplying sheet material following the reciprocating motion of the die 24 for supplying sheet material.

The die 24 for supplying sheet material consists of a wide die which is generally called as a T-die; the molten resin is slightly chilled by this die 24 and is fed out from the tip of this die 24 as a semi-molten sheet.

Although it is not illustrated, the moveable base 25 is adapted to smoothly reciprocate by means of a guide member provided in the fixed table 26.

The press mold set 40 is provided adjacent to the fixed table 26 which supports the moveable die unit 17 and is comprised of a lower cold press mold 35 and an upper cold press mold 34. The upper mold 34 is adapted to move vertically relative to the lower mold 35 by means of a drive unit such as a hydraulic cylinder unit not shown in the drawings.

As the die 24 reciprocates, carried by the moveable die unit 17, the die 24 moves along the mold surface of the lower cold press mold 35 between the position interposed between the upper and the lower mold 35 and 34 as indicated by a chain dot line in Figure 5 and the position out of the space between the upper and the lower mold 35 and 34 as indicated by a solid line in Figure 5.

The drive unit for the moveable die 24 consisted of a ball screw mechanism using the servomotor 27 and the feed screw rod 28 in the present embodiment, but,

instead, a hydraulic cylinder may be directly connected to the moveable die 24 for achieving the reciprocating motion.

As shown in Figure 6, the semi-molten thermoplastic resin material in a sufficiently plastic state is filled into a cavity 35a defined in the lower press mold 35. The cavity 35a is provided with grooves 36 in the pattern of a grid for forming the spacer ribs 12. In the present embodiment, the thermoplastic material consists of 20 to 30 weight % of ethylene-vinyl acetate copolymer, 5 to 10 weight % of ethylene-propylene rubber, 5 to 10 weight % of atactic polypropylene and 70 to 50% of inorganic filler.

Ethylene-vinyl acetate copolymer contributes to improving the adaptability of the thermoplastic material for extrusion and gives the product a rubber-like softness. If the content of ethylene-vinyl acetate copolymer is less than 20 weight %, favorable extrusion may not be possible. Conversely, if the content of ethylene-vinyl acetate copolymer exceeds 30 weight %, the product may lack the desired softness.

Ethylene-propylene rubber gives the thermoplastic resin material a sufficient viscosity in its semi-molten state for favorable extrusion results. The thermoplastic resin will lack a sufficient viscosity if the content of ethylene-propylene rubber is less than 5 weigh % but will lose adaptability for extrusion if its content exceeds 10 weight %.

Atactic polypropylene improves the cohesion between the resin contents and the filler in the

thermoplastic resin product and, additionally, reduces the viscosity of the thermoplastic resin material in its semi-molten state. Thus, the cohesion between the resin contents and the filler will become insufficient if the content of atactic polypropylene is less than 5 weight % and severing of the product tends to occur as it is being extruded from the nozzle of the extruder 15 because of insufficient viscosity if the atactic polypropylene content is greater than 10 weight %.

The filler may consist of such materials as calcium carbonate, mica and other conventional materials. Sufficient acoustic insulation results may not be obtained if the content of the filler material is less than 50 weight % and the tear strength may be insufficient and the spacer ribs could be damaged when removing the product from the mold if the filler content is greater than 70 weight %.

Thus, generally favorable results can be obtained if the thermoplastic material consists of 20 to 30 weight % of ethylene-vinyl acetate copolymer, 5 to 10 weight % of ethylene-propylene rubber, 5 to 10 weight % of atactic polypropylene and 70 to 50% of inorganic filler.

These ingredients are uniformly mixed with a Henschel mixer and further mixed and heated in an extruder. Thereafter, the thermoplastic material is obtained as pellets, which are suitable for use in a stamp molding process, from the die of the extruder. Thus, an insulation panel of a desired shape can be

obtained by a stamp molding process using thus prepared thermoplastic material.

According to a specific embodiment of the present invention, the thermoplastic material consists of 20 weight % of ethylene-vinyl acetate copolymer, 10 weight % of ethylene-propylene rubber, 10 weight % of atactic polypropylene and 60 weight % of calcium carbonate.

The mixture of this composition was mixed in a Henschel mixer and converted into the form of pellets with an extruder. The pellets are then supplied to the extruder 15 shown in Figure 5 to be made appropriately plastic by heating and to be metered for distribution over the lower mold 35. Then, the upper mold 34 is lowered and the thermoplastic material is formed into the dashboard insulation panel 11 having spacer ribs 12 projecting from the reverse surface thereof.

According to the above mentioned composition, the thermoplastic material is favorably released from the moveable die 24 and spread over the mold surface. Furthermore, the MI (melt index) of the material is 2 to 3 grams per ten minutes and the material is sufficiently capable of following the complex contour of the mold surface and being formed into the dashboard insulation panel 11 having a complex shape.

Since the hardness of the insulation panel formed by this stamp molding system is 85 to 90 (Shore A hardness based on JIS), the product is provided with a rubber-like softness and can favorably conform to the shape of the dashboard panel. Furthermore, since the tear strength of the product is 40 to 60 kg/cm^2, the

spacer ribs would not be damaged in the process of removing it from the mold set 40.

In the above described embodiment, the spacer ribs 12 were arranged in the manner of a grid, but, alternatively, the spacer ribs may be arranged in the manner of a honeycomb. In either case, the rigidity and the mechanical strength of the insulation panel in bending deformation are much improved. If rigidity and mechanical strength are not important, the spacer ribs may be formed as pins projecting from the reverse surface of the insulation panel as long as they can maintain the clearance between the insulation panel and the dashboard panel.

Figures 9 and 10 show the process of producing a second embodiment of the insulation panel assembly according to the present invention. As shown in Figure 9, an absorption layer 14 is placed on the lower mold 38 while an insulation panel 10 is placed on the upper mold 37 with its spacer ribs 12 facing downward. The absorption layer 14 is provided with slits 39 for receiving the spacer ribs 12 therein. In this embodiment, the cavities may be formed at intersections of the spacer ribs 12 so that the slits 39 in the absorption layer are not required to extend completely through the absorption layer 14 and the absorption layer may thus be handled as a single piece. Then, the upper mold 37 is lowered over the lower mold 38 and the absorption layer 14 and the insulation panel 11 are combined into an integral assembly.

When the absorption layer 14 consists of soft urethane foam, it is possible to form the urethane foam within the space between the spacer ribs 12 and combine them into an integral assembly.

As described above, according to the present invention, since the insulation panel assembly is produced by mold press forming so as to conform to the shape of a corresponding vehicle body panel and is provided with spacer ribs, a proper clearance is maintained between the insulation panel and the vehicle body panel at all time. Therefore, even when an absorption layer which may be interposed therebetween has lost its bulk because of aging and other reasons, the insulation panel assembly of the present invention can maintain its capability to prevent transmission of noises. Alternatively, it is possible to do away with the absorption layer and simplify the production and the assembly process of the insulation panel assembly.

As shown in Figure 12, a prior art dashboard insulation panel assembly 1 is attached to a bulkhead panel or a front dashboard panel 4 of a motor vehicle for the purpose of keeping noise and vibrations from an engine room 2 from a passenger compartment 3. A floor insulation panel assembly 5 is placed over a floor panel 6 for keeping out external noise, and the vibration of the floor panel resulting from the rolling contact of the tires with the road surface, and of the engine.

The structure of the insulation panel assembly 1 is typically as shown in Figure 13. It comprises two layers: a first layer is an acoustic insulation panel 7 made of a PVC or rubber sheet, while a second layer is an acoustic absorption layer 8 which is lined onto the reverse surface of the sound insulation plate 7 and is made of felt, urethane foam, or glass wool for example. When this assembly is fitted on a dashboard panel 4 of a motor vehicle, the acoustic absorption layer 8 leaves a clearance between the dashboard panel 4 and the insulation panel 7. This double wall structure is effective for reducing the transmission of noises from the engine room 2 to the passenger compartment 3.

Further, since the thickness of the sound absorption layer 8 can be varied as desired, it is possible to vary the width of the clearance between the dashboard panel 4 and the insulation panel 7 from one place to another. Therefore, it is possible to maximize the performance of the dashboard insulation panel assembly 1 with a minimum cost by preparing a plurality of pieces of acoustic absorption material for the absorption layer 8 having different thicknesses, and bonding then to appropriate parts of the insulation panel 7.

However, a dashboard insulation panel assembly of this structure tends to lose its capability to keep out noises after a long period because the material of the absorption layer 8 may be degraded, and the clearance between the dashboard panel and the insulation panel tends to change substantially from its initial setting.

To attach a plurality of pieces of sound absorption material having different thicknesses to the sound insulation panel 7 is cumbersome and detrimental to production efficiency.

CLAIMS

1. An insulation panel assembly for an interior surface of a motor vehicle comprising an insulation panel conforming to the surface on which it is to be mounted, and spacer means projecting from a reverse surface of the insulation panel.

2. An assembly according to claim 1 wherein the spacer means comprise a plurality of ribs integrally projecting from the reverse surface of the insulation panel.

3. An assembly according to claim 1 or claim 2 comprising an absorption layer of porous material interposed between the insulation panel and the vehicle body surface.

4. An assembly according to claim 3 wherein the absorption layer consists of molded foam material having slits for receiving the spacer ribs.

5. An assembly according to claim 3 wherein the absorption layer consists of foam material formed in a space between the insulation panel and the vehicle body surface.

6. An assembly according to any preceding claim wherein the surface is that of a dashboard panel.

7. An assembly according to any of claims 1 to 5 wherein the surface is that of a floor panel.

8. Apparatus for producing an insulation panel assembly according to any preceding claim cimprising an extruder for supplying a sheet of thermoplastic material in a plastic

state, a first mold part having a plurality of cavities for forming spacer means of the assembly, and a second mold part adapted to cooperate with the first part for forming the thermoplastic material into the assembly.

9. Apparatus according to claim 8 comprising means for moving an outlet of the extruder for laying the sheet of thermoplastic material over the mold surface of the first mold part.

10. An insulation panel assembly for an interior surface of an automotive as herein described with reference to Figures 1 to 3, 4 or 8 of the drawings.

11. Apparatus for producing an insulation panel assembly as herein described with reference to Figures 5, 6, 7, 9 and 10 of the drawings.

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